VOLUME XXIV NUMBER 10 WHOLE NUMBER 199

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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PUBLISHED MONTHLY
(*Ten numbers per year*)

December, 1930

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Vol. XXIV, No. 10 DECEMBER, 1930 Whole No. 199

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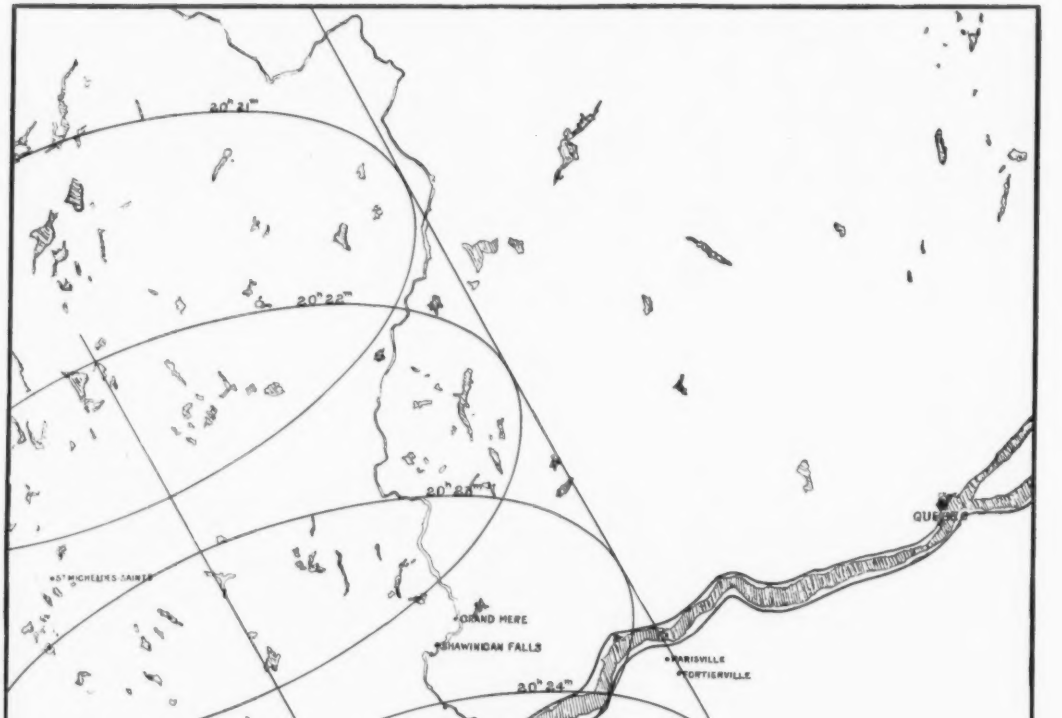
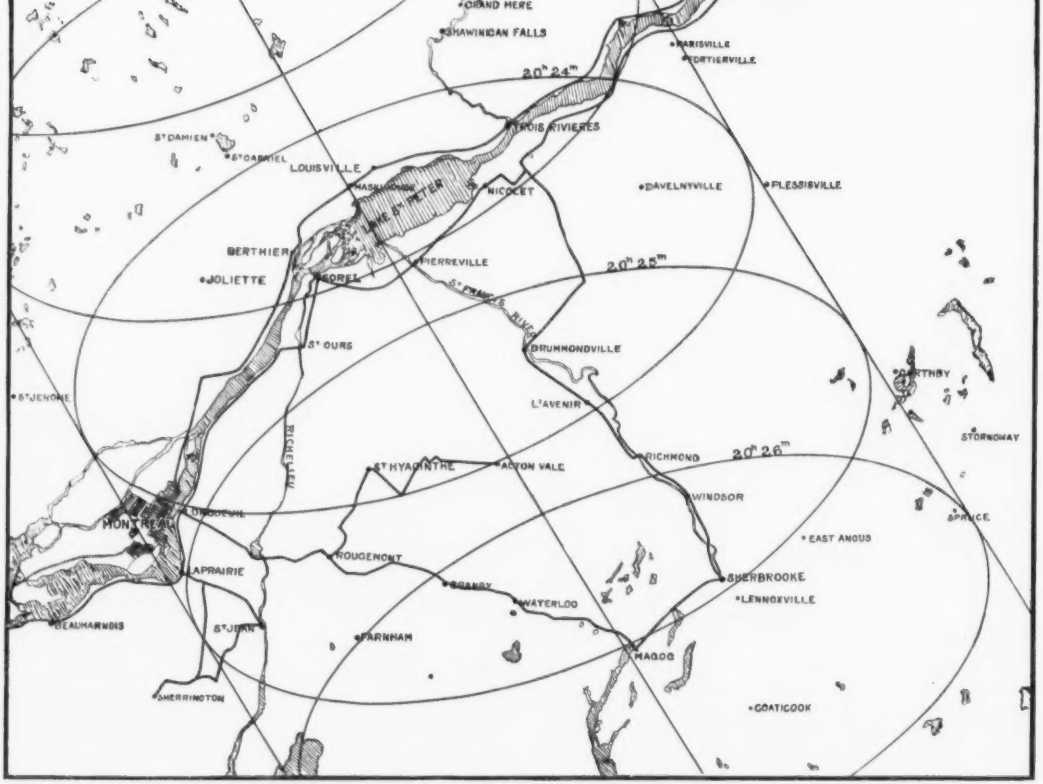
PLATE XXVIII.





PATH OF THE CENTRAL SHADOW OF THE ECLIPSE OF AUGUST 31, 1932, ACROSS QUEBEC.

Journal of the Royal Astronomical Society of Canada.

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VOL. XXIV, No. 10 DECEMBER, 1930 Whole No. 199

ECLIPSE OF THE SUN, AUGUST 31, 1932

By R. K. YOUNG

With Plate XXVIII

The accompanying diagram gives the path of the umbral shadow of the eclipse of the sun, August 31, 1932, across Quebec. The ovals represent the position of the shadow for successive minutes from Greenwich Civil Time 20h 21m to 20h 26m. These times correspond to Eastern Standard Time 3h 21m p.m. to 3h 26m p.m. The shadow moves across the area covered by the map in about five minutes. The three slanting lines which run from the upper left toward the lower right of the diagram show the limits of the area for which the eclipse will be total, as well as the central line. The duration of totality will be about 1m 42s, which is the time taken by the shadow to pass a point on the central line. Observers not on the central line will see the sun eclipsed for a shorter time. The shadow of the moon seems to advance in a direction perpendicular to the ellipse of shadow, consequently to observers on the eastern edge the shadow will appear to approach from the west or north of west, while for observers on the western edge of the belt of totality the shadow will appear to approach from the north or north-east. The map shows some of the larger centres of population. Sorel, Maskinonge, Pierreville, Actonvale, Magog are near the central line. The western limit passes through the city of Montreal, the greater part of the city lying within the belt of totality. The map also shows some of the main automobile roads.

SEISMOLOGY AT THE DOMINION OBSERVATORY

By S. Gold

Whenever a severe earthquake occurs in any part of the world, instruments at the Dominion Observatory are waiting for it, ready to record all the disturbances in the earth caused thereby. At first sight it seems remarkable that the instruments should pick up the movements which are, for distant earthquakes, quite imperceptible to the senses. This is to be explained by the fact that our sensations of motion of any kind depend essentially on the acceleration or change of velocity of the earth particle on which we stand. The latter, in the case of a large but distant shock, may move with an amplitude as great as three or four millimetres but, provided it takes a few seconds to sway back and forth, the human mind is incapable of perceiving the motion.

Although the actual time an earthquake lasts at its origin may be only a matter of seconds the waves set up in the earth by the shock are reflected at and refracted by surfaces of different density in the interior of the earth, as well as internally at intermediate points on the surface from the origin to the observer, until the energy of the shock is dissipated. For this reason seismographs record severe earthquakes for two or three hours, and often longer.

The Seismograph

The purpose of the seismograph is to record the movements of the earth. As the earth sways to and fro, a sensitive seismograph produces a record from which the period, the acceleration, and the actual displacement of the earth's surface at the recording station can be calculated. For a distant earthquake it is possible, provided the seismogram is a good one, to determine not only the distance to the epicentre, or origin of the disturbance, but also the time the shock began at this epicentre. Besides these uses the seismograph yields our most definite information concerning the interior structure of the earth.

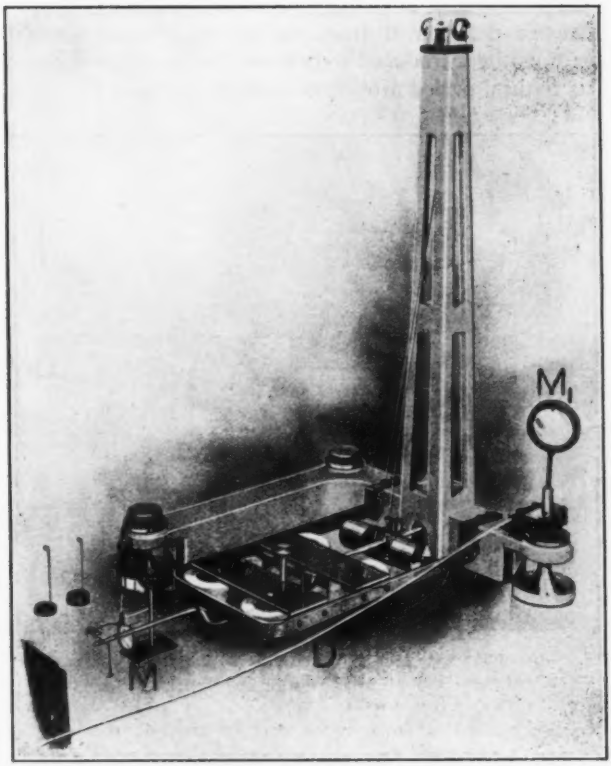


Fig. 1—HORIZONTAL SEISMOGRAPH
M, reflecting mirror; *D*, damping magnets; *m*, stationary mass; M_1, calibrating mirror.

Fundamentally, the seismograph is a pendulum, except that the motion is reversed. It is the bob or heavy mass of the pendulum which remains stationary while the earth swings. Any motion of the earth's surface is accordingly picked up and recorded. Provided the instrument is properly damped, the true earth movement can be determined from the resulting seismogram. The damping must be introduced to prevent the pendulum from swinging in its natural period after it receives an impulse.

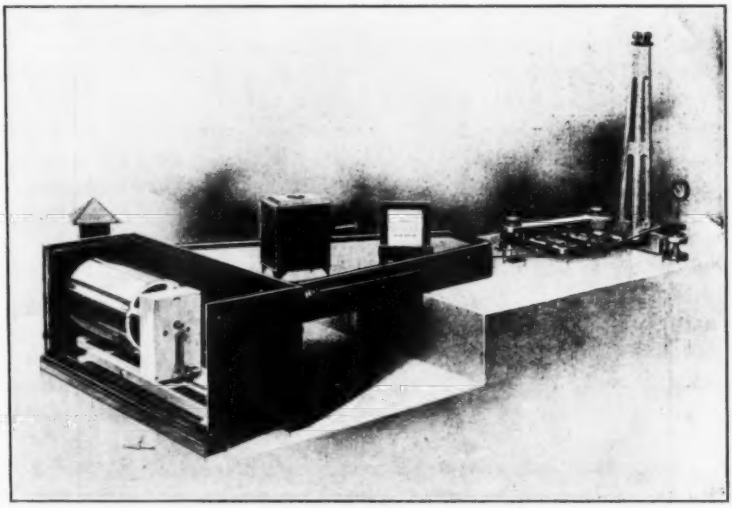


Fig. 2—HORIZONTAL SEISMOGRAPH AND RECORDING DRUM.
This view shows them set up on the cement pier at the observatory.

Several types of seismographs are at present made, but the best are photographic. Of the five seismographs now recording at the Dominion Observatory, four are photographic while the other records on a sheet of smooth calendered paper, which has been smoked over an ordinary coal oil burner and which is afterwards "fixed" by being given a coat of shellac. The figures show the vertical and one of the horizontal seismographs at the Observatory.

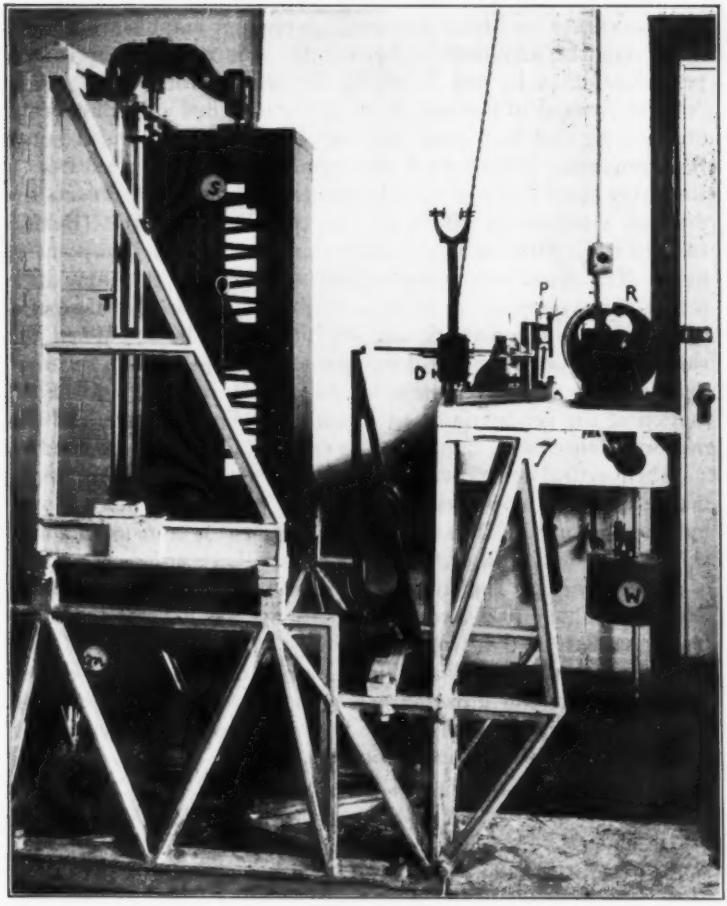


Fig. 3—VERTICAL SEISMOGRAPH.

S, supporting spring; *m*, stationary mass; *T*, temperature compensation; *D*, damping chamber; *P*, recording pen; *R*, rotating drum; *W*, heavy weight causing drum to rotate.

The horizontal instrument records the motion of the earth parallel to the surface, but not up and down. Divested of all its appliances for reducing friction, providing amplification, and modifying the amplitudes, the apparatus is a simple horizontal pendulum, that is, one in which the axis of rotation is nearly vertical, instead of horizontal; to this is attached a small concave mirror. Several feet away are the recording drum and a lamp. A photographic sheet covers the drum. Light is projected from a slit in the lamp to the mirror of the seismograph, which reflects the ray into a horizontal slit on the box covering the drum. Behind this slit is a cylindrical lens which converges the ray to a point of light. The drum rotates once every hour and at the same time moves about one quarter of an inch to the right, so that the point of light traces out a continuous line forming a helix. When the sheet is removed from the drum the record appears as a series of parallel lines, each representing an hour's registration. Each motion of the pendulum causes a corresponding movement of the mirror. Hence every motion of the earth is accurately recorded.

The vertical seismograph depends on the inertia of a heavy mass supported by a spring. It records the up and down movements of the earth. The vertical displacement is transformed into a horizontal one by a system of levers and is recorded on a sheet of smoked paper. The latter is mounted on a drum which rotates once every hour and moves gradually to the left, producing a record similar to that from the photographic instrument. The clockwork for the recording drum is weight driven, the controlling device being a ball governor which permits smoother recording than would be possible by a pendulum control and which is less likely to be stopped by an earthquake.

The Seismogram

In every earthquake there are three distinct types of waves, which always arrive in the same order at any station. These are: (1) longitudinal waves,—waves of compression and rarefaction, like sound waves; (2) transverse waves,—waves of distortion, like light waves; and (3) surface or long waves, which are both longitudinal and transverse. The first two types travel through the

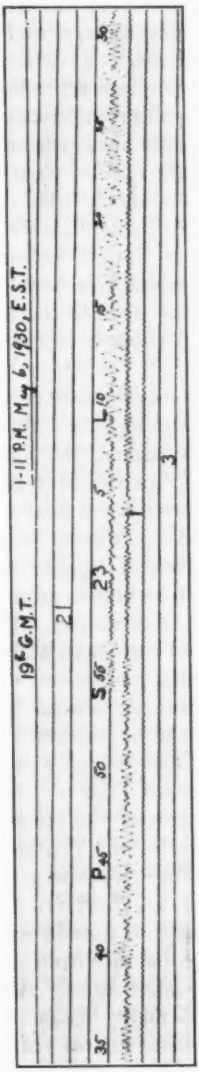


Fig. 4—SEISMOGRAM OF EARTHQUAKE IN NORTHERN PERSIA ON MAY 6, 1930.

earth while the last is confined to the crust. Respectively, these waves are called the first preliminary, or *P* waves, the second preliminary, or *S* waves, and the long, or *L* waves. All three waves are clearly seen in the seismogram reproduced in the figure.

It has been found by observation that the time between the arrival of the *P* and *S* waves always bears a fixed relation to the distance of the seismograph station from the epicentre, and also to the time of travel of the shock from the origin. Tables have been constructed from which this distance and time can be determined when the difference of time between *P* and *S* is known. Further experimental investigations have led to other methods of reading seismograms which furnish checks on the above calculations. The detailing of these is not within the scope of this article.

Inspection of the seismogram will reveal short breaks in the lines. These are the minute signals. During the 60th second of each minute, by magnetic means, the light is shut off from the lamp for the photographic instruments and the pen is raised off the smoked sheet for the mechanical instrument so that there is no record for that second. At every exact hour this signal is omitted. Hence the time of any phase of an earthquake can be accurately read from the seismogram in hours, minutes, and seconds. The time service is that of the Observatory. Time, as recorded on the seismographs, is maintained correct to within a fifth of a second.

In order to simplify the comparison of records between seismograph stations, the sheets are always read in Greenwich Mean Time. Thus the earthquake on the seismogram shown began at 22h 44m 32s on May 6th, 1930, which was 5h 44m 32s p.m. on the same day in Eastern Standard Time.

To determine the distance of the epicentre from the recording station the times of arrival of the *P* and *S* waves must be read from the seismogram. These two sets of waves are well marked on the record shown in Fig. 4. *P* arrived at 22h 44m 32s and *S* at 22h 54m 22s. The difference in time is accordingly 9m 50s. Referring to a set of tables the distance from station to origin is found to be 8600 kilometres or 5350 miles. Another table yields the information that the earthquake began at 22h 34m 24s at the origin. From experience these figures are known to be correct to

within one per cent. for this distance. This *S-P* method fails when the distance is less than 700 or more than 7000 miles.

In order to locate the position of the epicentre on the earth from a single station, three seismographs are needed, two horizontal instruments set at right angles, and one vertical. If the horizontal machines are set North-South and East-West, the horizontal components of the initial earth motion can be determined for these two directions, and by combining them, the great circle through station and epicentre is deduced. The vertical indicates the direction along this circle from the station. Thus if the horizontals determine the great circle as running Northwest and Southeast, then the vertical shows whether the epicentre lies to the Northwest or to the Southeast. By an examination of the very first trace of the first preliminary or *P* waves the direction of the origin can thus be determined. The distance being known from previous calculation, the epicentre is located.

When the initial impulses are indefinite, but when the distance can be deduced, then the distances from three suitably distributed stations are required for the position of the epicentre. Each distance furnishes a distance circle, with centre at the respective station, and the three circles intersect at a point which defines the origin.

Routine and Research Work at the Observatory

Of the five instruments at Ottawa two are Milne-Shaw horizontal seismographs, two Bosch horizontal, and the fifth is a Spindler and Höyer vertical. The sheets on all these instruments are changed once each day in the morning. In addition three meteorological instruments are also kept in operation in the seismological division: a microbarograph, which records slight variations in atmospheric pressure; an anemograph, which records the pressure and direction of the wind; and a thermograph, which records temperature changes. The sheets from all these machines are carefully scanned, annotated, and filed.

All earthquakes recorded at Ottawa are given a serial number. Every month the Observatory issues a seismological bulletin which is sent to all seismic stations. Similar bulletins are received from

other stations and these are systematically filed. Any bulletin desired is always ready for reference. This is of great aid in the location of epicentres.

Seismological stations are located at Shawinigan Falls and Seven Falls in Quebec, at Halifax, and at Saskatoon. These are under the direct control of the Dominion Observatory, which supplies the sheets and inspects the instruments from time to time. All seismograms recorded are sent to Ottawa where they are read and filed. Monthly reports are issued for the Quebec stations. These include "correlation" sheets, which compare the earthquakes registered during the month at these stations with those at Ottawa.

At present the seismicity of Eastern Canada is being studied at the Observatory. When the Shawinigan Falls and Seven Falls records are examined, special attention is paid to "local" shocks, *i.e.*, earthquakes occurring within a range of 300 miles of the recording station. It is believed that there are certain relations between the occurrence of these and major earthquakes in the same area. In order to make a complete determination of the seismicity of this region, one more seismographic station is required in northern Quebec. This would complete a triangle of observing points by means of which the interior earth structure could be studied.

Publications

From time to time complete analyses and reports are undertaken for major quakes that occur in and adjacent to Canada. For example, when the disturbance of February 28, 1925, happened in Quebec, a great amount of field work was done in the vicinity of the epicentre and much information was collected. Questionnaires were distributed, photographs of different affected objects were taken, some of the ground was surveyed, and tide gauge records of the St. Lawrence river stations were obtained. For the Grand Banks earthquake of November 18, 1929, over 200 seismograms from stations all over the world were secured. These were all read at Ottawa. In addition the transatlantic cable companies furnished much specific information concerning the location of all cable breaks caused by the shock.

The Bibliographical Bulletin is issued quarterly by the Observatory. It is designed to be a complete index, with short

abstracts, of all seismological publications or magazine articles pertaining to seismology or allied subjects. As a result the Observatory is gradually becoming a central reference bureau for publications in seismology.

Until recently epicentres were deduced for all well-recorded earthquakes. These determinations were published yearly under the title "The Location of Epicentres for 19.." from 1911 to 1927. Owing to the fact that this work is now being done at Oxford University, the Observatory has discontinued this publication.

Besides earthquakes there are many effects which a seismograph can record. Movements of a high tower or chimney caused by the wind, may be traced out on a seismogram. The vibrations of a bridge caused by moving loads, or the slipping of the foundations of a building may be so detected and registered. An instrument placed on a locomotive will indicate the less perfect portions of a railroad track. Successful experiments are at present being carried on in the location of oil and ore by seismic methods.

From an engineering point of view the study of earthquakes is of the utmost importance. With the rapid growth of large cities, the rise of immense buildings, and the construction of networks of water and lighting systems, the damage possibilities of a severe shock are greatly increased. Earthquake-resistant buildings are now being developed.

A word may be said concerning the prediction of earthquakes. It seems possible that disturbances may some time be predicted for limited areas where shocks are frequent. At present quakes are predicted with more or less accuracy for certain locations in Japan. Before shocks can be foretold for any given locality, the seismic history of that particular place must be studied for many years. As previously indicated, such studies are now being made by the Dominion Observatory for Eastern Canada. It may safely be said that earthquake predictions appearing from time to time in newspapers are quite without scientific foundation.

In conclusion the writer desires to acknowledge his indebtedness to Mr. E. A. Hodgson, seismologist at the Observatory, for suggestions and advice.

Dominion Observatory,
Ottawa, August, 1930.

THE MILKY WAY AND BEYOND

By H. R. KINGSTON

A Radio Talk over CJGC, London, Ontario

During the past 25 years astronomers have become more and more interested in the outlying regions of our universe. This interest has been stimulated by the wonderful development of instruments for the study of the stars. Our great telescope at Victoria, B.C., whose mirror is six feet in diameter, and the world's mightiest telescope over eight feet in diameter, on Mount Wilson, near Pasadena, California, have put into the hands of modern astronomers a power for penetrating the depths of the universe that was unknown a generation ago. Further, there has been a correspondingly marvellous development of new and powerful instruments which are attached to our telescopes for various kinds of research, such as determining the kinds of gases in the atmospheres of the stars, the sizes of the stars, their distances from us, the speeds at which they are moving, their temperatures, and a great many other facts which must be known before we can have any adequate idea of our universe.

With our present huge telescopes one might expect a star to appear of considerable size, yet the fact remains that thus far no telescope has been made sufficiently powerful to magnify a star to anything beyond a mere bright point. The size of a star is not shown in any telescope. Possibly some day super-giant telescopes will be made which will be powerful enough to show up a star as a little round disc. But the marvellous thing is that even though no telescope now in existence is powerful enough to enable us to "see" the size of any star, yet an instrument called an interferometer has been devised, which, when attached to the largest telescope, actually tells us the sizes of the stars. By this means we have found that many stars are larger than our sun and some of them nearly 100 million times as large.

It might be of interest here to state that up to 1928 all the glass discs for the large mirrors for telescopes were made in Europe, but

in February of that year a 70-inch disc was uncovered at the Bureau of Standards at Washington, which in a molten state had been put away carefully eight months before and had been allowed to cool very, very slowly during all that time in order to produce a uniformly excellent grade throughout the entire mirror. This mirror weighs about 5000 pounds. It is evident from this that the construction of mirrors for very large telescopes is a most difficult matter indeed.

Before we can properly discuss the regions beyond the Milky Way, we must say considerable about the Milky Way itself. Indeed, most of my talk to-night will be about the Milky Way, or, as it is often called, "The Galaxy".

On any clear night when there is no moon, the Milky Way looks like a faint, pearly, somewhat irregular band across the sky, where the stars are much more numerous than in other parts of the heavens. Most of us probably do not think of those stars lying away from the Milky Way as having anything to do with it, and yet the fact is that all the stars that we can see with the naked eye in every direction and hundreds of millions that only the telescope, aided by the most sensitive photographic plates, can bring to us, all form a part of the Milky Way. "But", you say, "most of the stars are not in the direction of the Milky Way; hence, how can they be a part of it?" To answer this let me give an illustration. Imagine a large ferris-wheel, about ten times as high as it is wide or thick. That is, if each seat is three feet wide the ferris-wheel is about thirty feet high. Now suppose that hundreds of lights are hung all through the ferris-wheel and suppose further that you are standing on a little platform up close by the axle of the wheel. You will readily see that as you look out towards the edge of the wheel, that is, towards the seats, you will see many more lights than when you look out sideways along the axle of the wheel. It is just like this when we look out at the stars. All the stars we see belong to the Milky Way. The Milky Way is not just the rim of a wheel around us but it is the whole wheel or disc. Now it happens that our sun, which, of course, is one of the stars, is somewhat near the centre of this disc and the earth is very close to the sun and, therefore, we are right in the midst of an immense ferris-wheel-shaped swarm of stars. Again,

we might illustrate the shape of our Galaxy by a thin watch or by two plates placed face-together.

We said before that the earth is close to the sun. Now we all know that the sun is 93 million miles from us and perhaps, then, we feel a bit suspicious of the statement that we are close to the sun. But distances are only relative. Three thousand miles across Canada is a very great distance if thought of in terms of the distance over which we ordinarily move in a day. But if we are making a 25-thousand-mile trip around the world we do not consider three thousand miles very great. When we think of the 93 million miles separating us from the sun, we feel that it is a great distance when compared with any distances between places here on the earth. But suppose we ask ourselves how far it is from our sun to the nearest other sun, that is, to the nearest star in the heavens. This distance turns out to be 270 thousand times the distance of the earth from the sun. Most of the stars are hundreds and even thousands of times as far away as the nearest star. Surely, then, we are not wrong when we say that the earth is relatively very close indeed to the sun. In round numbers, our sun's nearest starry neighbour is 25 millions of millions of miles away.

Suppose we let the sun be represented by a small walnut on a table in the centre of your room; then our earth will be the size of a grain of dust at a point about eight feet away from the walnut, that is near the wall of your room. But on this same scale the nearest star will be 400 miles away, or farther away than Montreal is from Toronto. Surely our sun must be very lonesome amongst the stars!

When we go beyond our sun's nearest starry neighbour, and consider the stars which are thousands of times as far away as this one, we can only gasp at the array of figures. However, after all, the situation is not entirely hopeless. The trouble is that a mile is altogether too short a measuring stick for the stupendous distances we have to consider. Let us now step out into space with a good big measuring rod. We shall take for this the distance that light or electricity or a radio wave travels in one year. Now a light wave or a radio wave will travel over seven times around the earth at its equator in one second, or 186 thousand miles in a second. In a year, at this unthinkable speed, light will cover six

million millions of miles. This tremendous distance we shall now take as our yard-stick. Surely a measuring stick six millions of millions of miles long will be adequate for measuring any distance! We call this distance a "light-year", since it is the distance light travels in one year. Now let us step aboard a beam-of-light train and start to explore the Milky Way and beyond. "Fast but not furious" will be our trip. Don't forget that in every single second we are going to travel 186 thousand miles. Our conductor calls "All aboard". We are off! We cannot stop at the moon—indeed, we are past the moon before we have drawn our first breath, in fact before our third heart-beat. It takes us a second and a quarter to reach the moon. No, we do not stop at the moon, in fact, we have only about time to remove our coats and hats, get comfortably settled for our trip and read the first comic strip in the evening paper when our conductor announces the first station, "the sun", where we arrive just eight minutes after leaving the earth.

The sun is not very hospitable just now, for a number of terrific cyclones are in action there—they call them "sun-spots" back there on the earth—and anyhow we must hurry on.

As we start on we turn again to our evening paper and by-and-by, becoming tired of reading, we glance at our watches and find that an hour has passed. Just then our conductor comes along and we say, "How long till the next stop?" "O, bless your heart", says the conductor, "you aren't getting restless yet, are you? Why, we don't reach the next sun till over four years from now!" "Well, did you not tell us that this was a fast train going 186 thousand miles every second?" "Yes, that is correct, and we are keeping right up to schedule, but you must remember that this is a big country out here. In fact, after we have passed four or five stations we do not have any more birthdays, which is lucky, for, as I said before, this is a big country, and it takes a long time to traverse it. It will take us fifteen thousand years to get out to the side of the Milky Way at its narrowest, and if we go to its farthest edge we shall require ten times as long, that is, about 150 thousand years; and since we started from near the centre we shall even then have traversed only half-way across our universe." Continuing, our conductor says, "Putting this a little more techni-

cally, our universe of stars has the shape of a watch whose thickness is about 30 thousand light-years and whose diameter from edge to edge is approximately 300 thousand light-years."

"The number of stars in our universe is astounding. Our largest telescope reveals 1500 million on the photographic plates. This is about one star for every man, woman and child in the world at the present time. But even this is only a small fraction of the total number. Professor Eddington has estimated that the grand total of stars in our universe is about 300,000 million, *i.e.*, about 200 for each person living in the world to-day."

"In some parts of this universe there are great families or clusters of stars—sort of miniature universes when compared with the Milky Way. In one of those, 'the Star Cluster in Hercules', there are 35 thousand suns brighter than our sun, and it would take us on our beam-of-light train 160 years to cross from one side of this cluster to the other."

"But," we ask, "is there anything beyond the Milky Way?" "Yes, says he, "there are thousands of other universes of stars, and a striking thing about them is that a very large number of them appear to be huge whirlpools. They are called 'spiral nebulae', and being beyond our own universe they have been described also as 'island universes'. They contain immense numbers of stars, and clouds of gas, many of which we believe are gradually condensing into stars. Probably, if from one of these we could look back upon our own universe, it too would be a great whirlpool of stars." "How far away are these?" "Well, the farthest that we can reach with our present largest telescope are about 140 million light-years away." "But, is there anything beyond them, or are they at the outer edge of creation?" "Now", says our conductor, "this is too big a question for me, and at present we cannot answer it with certainty, but it seems probable that other universes extend on and on and on, but the end or boundary is still an open question."

University of Western Ontario,
London, Ont.

MAGNETIC VALUES FOR AGINCOURT AND MEANOOK

By W. E. W. Jackson

A summary of the results obtained at the Agincourt and Meanook magnetic observatories during the years 1927-28 is presented below in tabular form. The mean monthly values of declination, horizontal force and vertical force at Agincourt and the declination and horizontal force at Meanook are obtained from the photographic records, and they are the means of all the daily values, which in turn are the means of the 24-hourly values, each hourly value being the average value of the element for one hour extending from one half-hour preceding to one half-hour following the hour of Greenwich time.

The photographic results are controlled by absolute observations made once a week for declination and horizontal force and twice a week for vertical force.

The mean monthly values of the inclination for Agincourt are derived from the means of the horizontal and vertical forces.

The mean monthly values of the inclination for Meanook are the means of absolute observations made with the earth inductor twice a week, one observation in the morning and one in the afternoon in order to nearly eliminate the diurnal variation. The mean value of inclination so obtained, together with the mean horizontal force from the photographic record, is used to determine the vertical force for Meanook.

The final table gives a summary of the annual values of the different elements from 1918 to 1929, each yearly mean being the average of the 12 monthly means.

AGINCOURT DECLINATION WEST

Month 1928	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	° ′	° ′		° ′		° ′	′	
January...	7 18.3	7 38.5	1	6 42.5	27	0 56.0	10.6	14.6
February..	18.6	7 29.2	21	7 0.4	19	0 28.8	10.8	15.0
March.....	19.3	7 39.2	11	6 51,0	14	0 48,2	12.0	16.9
April.....	19.9	7 42.0	7	6 35.0	20	1 7.0	14.0	18.9
May.....	19.8	8 44.5	29	6 28.5	28	2 16.0	12.0	28.6
June.....	19.4	7 49.4	13	6 57.4	2	0 52.0	14.0	22.9
July.....	20.4	9 28.1	8	6 3.1	8	3 25.0	14.9	32.5
August....	20.7	8 57.9	27	6 48.3	5	2 9.6	17.8	27.2
September.	21.1	7 49.5	8	6 44.6	8	1 4.9	13.4	23.8
October....	22.0	8 12.3	18	6 14.5	25	1 57.8	10.6	23.3
November	22.1	7 42.0	3	7 2.1	3	0 39.9	6.2	15.7
December..	22.0	7 39.2	1	6 53.6	6	0 45.6	6.4	12.4

AGINCOURT DECLINATION WEST

Month 1929	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	° ′	° ′		° ′		° ′	′	′
January...	7 22.4	7 35.0	5	7 01.2	9	0 33.8	7.5	10.8
February..	22.9	8 39.6	28	5 55.1	28	2 44.5	8.0	25.1
March.....	23.7	8 50.4	12	5 52.9	12	2 57.5	11.3	30.9
April.....	23.3	7 39.4	16	6 55.4	17	0 44.0	12.9	18.3
May.....	23.3	7 37.2	30	6 55.8	12	0 41.4	13.4	20.4
June.....	23.2	7 35.9	22	7 3.3	7	0 32.6	13.9	18.7
July.....	23.6	8 0.4	10	6 30.7	15	1 29.7	13.2	22.0
August....	24.2	7 44.9	18	6 49.8	2	0 55.1	16.1	23.5
September.	24.4	8 3.4	22	6 42.5	11	1 20.9	13.1	26.1
October....	25.1	7 53.1	9	6 48.7	31	1 4.4	7.3	21.0
November	25.6	8 40.4	3	6 57.8	4	1 42.6	6.8	18.9
December..	26.0	7 57.8	5	7 0.5	18	0 57.3	7.2	18.1

AGINCOURT HORIZONTAL FORCE

Month 1928	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	15650	15683	1	15574	27	109	43.6	56.6
February..	15650	15686	6	15597	26	89	43.5	57.3
March.....	15647	15682	26	15551	11	131	42.5	60.1
April.....	15647	15745	7	15578	8	167	55.0	79.7
May.....	15641	16107	28	15230	29	877	76.5	144.0
June.....	15639	15761	7	15460	13	301	48.1	99.0
July.....	15620	16057	8	15038	8	1019	60.7	140.2
August....	15615	15701	4	15253	27	448	61.0	113.1
September.	15611	15710	8	15468	8	242	69.4	98.2
October....	15602	15775	25	15444	18	331	48.5	98.1
November	15606	15655	10	15410	2	245	30.3	62.7
December..	15612	15643	24	15489	6	154	29.8	54.1

AGINCOURT HORIZONTAL FORCE

Month 1929	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	15610	15654	9	15534	14	120	32.5	49.3
February..	15598	15918	28	15190	28	728	48.1	112.6
March.....	15581	15774	12	15067	12	707	50.1	105.7
April.....	15599	15683	4	15473	16	210	42.6	67.9
May.....	15602	15676	15	15513	13	163	48.9	73.7
June.....	15602	15743	30	15495	10	248	48.2	79.7
July.....	15592	15775	15	15302	15	473	52.4	104.9
August....	15587	15798	1	15448	1	350	60.2	92.1
September.	15573	15648	7	15296	22	352	52.6	90.9
October....	15568	15613	4	15382	19	231	34.1	82.4
November	15565	15570	2	15210	3	360	34.6	71.2
December..	15559	15619	16	15405	5	214	33.5	68.3

AGINCOURT VERTICAL FORCE

Month 1928	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	57350	57368	20	57328	27	40	3.2	6 9
February..	57359	57372	20	57348	4	24	3.2	6.8
March.....	57352	57395	12	57328	23	67	4.3	8.6
April.....	57335	57376	7	57297	20	79	5.5	15.7
May.....	57315	57478	28	57022	29	456	24.2	52.6
June.....	57314	57346	22	57082	22	264	18.6	40.5
July.....	57313	57744	8	56902	8	842	22.5	67.9
August....	57296	57353	5	56998	27	355	17.4	43.2
September.	57291	57394	9	57186	8	208	14.2	41.6
October....	57296	57412	25	57035	18	377	15.5	42.5
November	57289	57342	13	57215	13	127	9.7	22.8
December..	57267	57305	5	57213	6	92	5.5	12.6

AGINCOURT VERTICAL FORCE

Month 1929	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	57263	57314	9	57248	11	66	2.9	7.9
February..	57256	57383	28	57038	28	345	12.8	35.8
March.....	57238	57312	12	56965	12	347	20.6	42.0
April.....	57214	57232	16	57115	16	117	7.3	18.8
May.....	57206	57251	14	57105	23	146	13.9	34.3
June.....	57202	57247	30	56964	10	283	17.5	39.9
July.....	57186	57438	15	56973	15	465	24.9	57.4
August....	57173	57347	1	57074	18	273	18.5	43.8
September.	57162	57217	22	57002	7	215	24.5	71.7
October....	57157	57253	16	57064	8	189	17.3	39.7
November	57151	57553	3	56781	3	772	23.3	41.0
December..	57147	57181	3	57028	5	153	15.3	28.4

MEANOOK DECLINATION EAST

Month 1928	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	° ′	° ′		° ′		° ′	′	′
January...	26 52.8	28 17.1	27	26 2.7	27	2 14.4	8.1	20.8
February..	49.2	27 20.9	16	26 25.8	21	0 55.1	9.5	22.0
March.....	47.8	28 27.8	11	25 8.9	11	3 18.9	10.1	30.8
April.....	46.0	27 46.7	7	26 4.3	10	1 42.4	15.4	46.0
May.....	48.3	28 38.2	28	25 7.5	29	3 30.7	16.7	52.7
June.....	48.8	28 31.2	22	26 14.4	22	2 16.8	17.6	39.2
July.....	47.9	28 39.5	8	24 49.8	8	3 49.7	17.5	47.0
August....	48.9	28 30.6	26	25 9.1	26	3 21.5	18.3	43.2
September.	48.8	28 10.4	25	25 28.9	25	2 41.5	14.2	39.4
October....	48.2	28 40.4	18	25 20.3	24	3 20.1	12.0	49.2
November	48.0	28 21.6	3	25 29.9	2	3 51.7	9.8	41.6
December..	47.4	28 11.1	6	25 14.0	6	2 57.1	5.5	28.1

MEANOOK DECLINATION EAST

Month 1929	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	° ′	° ′		° ′		° ′	′	′
January...	26 48.6	27 18.6	11	26 20.1	14	0 58.5	6.4	18.6
February..	47.7	28 32.1	17	24 51.0	28	3 41,1	8.9	45.7
March.....	43.8	28 34.3	15	24 50.8	12	3 43.5	11.4	55.8
April.....	41.6	28 13.4	4	25 23.9	16	2 49.5	14.0	29.7
May.....	42.3	27 43.6	13	25 47.9	13	1 55.7	16.2	32.8
June.....	44.3	27 32.2	30	25 54.0	10	1 38.2	16.9	32.4
July.....	42.2	28 3.4	16	25 36.8	15	2 26.6	19.8	39.2
August....	43.0	27 40.1	18	25 41.5	15	1 58.6	15.3	35.1
September.	42.4	28 26.0	22	25 8.4	22	3 17.6	12.3	41.7
October....	39.9	28 14.6	7	24 59.5	8	3 15.1	10.6	48.9
Novmber..	39.5	29 17.2	3	26 23.9	3	2 53.3	6.6	35.5
December..	40.0	28 30.6	5	25 54.6	5	2 36.0	8.0	39.8

MEANOOK HORIZONTAL FORCE

Month 1928	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	12781	13083	27	12097	27	986	33.9	104.5
February..	12790	12927	19	12390	21	537	36.3	123.2
March.....	12795	13189	14	12495	11	694	42.8	155.2
April.....	12810	13108	20	12297	10	811	43.1	148.4
May.....	12794	13358	28	11768	28	1590	130.9	383.1
June.....	12799	13164	23	11877	13	1287	123.8	311.2
July.....	12784	13737	8	12039	10	1698	128.4	356.8
August....	12786	13421	27	12080	7	1341	74.2	266.8
September.	12782	13198	9	12114	25	1084	73.4	271.7
October....	12772	13147	25	12008	18	1139	78.6	332.1
November	12784	13009	2	11957	3	1052	93.2	275.6
December..	12799	13024	12	12106	6	918	56.1	165.0

MEANOOK HORIZONTAL FORCE

Month 1929	Mean of Month	Maximum	Date of Max.	Minimum	Date of Min.	Month Range	Mean Daily Range	
							From 24-hour Readings	From Means of Extremes
	γ	γ		γ		γ	γ	γ
January...	12798	13349	9	12542	14	806	28.8	116.4
February..	12787	13536	27	11872	28	1664	108.1	281.7
March.....	12776	13404	12	11874	12	1530	127.1	373.3
April.....	12791	13187	16	12060	4	1127	43.7	176.2
May.....	12796	13125	13	12363	23	762	52.0	200.7
June.....	12794	13033	30	12280	10	753	49.8	174.9
July.....	12783	13312	15	12056	16	1256	90.9	286.5
August....	12782	13230	1	11945	1	1285	53.8	247.3
September.	12770	13096	7	11934	22	1162	95.1	308.6
October....	12761	13144	19	11999	30	1145	93.7	346.6
November	12766	13086	3	11905	3	1181	74.4	224.1
December..	12768	13037	23	11843	5	1194	93.1	283.4

MEAN MONTHLY VALUES OF AGINCOURT INCLINATION, MEANOOK INCLINATION AND MEANOOK VERTICAL FORCE FOR 1928 AND 1929

	Agincourt	Inclination	Meanook	Inclination	Meanook	Vertical Force
Year	1928	1929	1928	1929	1928	1929
Month	° ′	° ′	° ′	° ′	γ	γ
January	74 44.2	74 45.1	.....	77 54.7	.....	59757
February	44.3	45.6	77 55.1	55.7	59753	59790
March	44.4	46.3	55.2	56.9	59785	59841
April	44.1	45.0	54.5	54.4	59796	59699
May	44.2	44.7	54.0	54.8	59679	59756
June	44.3	44.6	54.0	53.7	59702	59653
July	45.3	44.9	53.9	54.8	59624	59695
August	45.3	45.0	54.8	54.7	59709	59682
September	45.5	45.6	54.5	54.9	59665	59643
October	46.0	45.8	55.9	55.7	59737	59669
November	45.7	45.9	.....	55.5	.....	59675
December	45.0	46.2	54.5	55.1	59744	59650

MEAN ANNUAL VALUES OF MAGNETIC ELEMENTS OBSERVED AT AGINCOURT AND MEANOOK FROM 1918 TO 1929 INCLUSIVE

						Intensity	
Observatory	Latitude	Longitude	Year	Declination (D)	Inclination (I)	Horizontal (H)	Vertical (Z)
	° ′	° ′		° ′	° ′		
Meanook	54 37N	113 20W	1918	27 44.3E	77 54.5	12938	60393
			1919	27 41.1E	77 54.2	12944	60400
			1920	27 38.6E	77 53.6	12923	60246
			1921	27 33.3E	77 53.7	12909	60190
			1922	27 28.5E	77 53.3	12904	60133
			1923	27 23.3E	77 53.2	12882	60031
			1924	27 17.7E	77 53.2	12866	59943
			1925	27 10.7E	77 53.8	12852	59934
			1926	27 4.2E	77 53.8	12832	59844
			1927	26 56.3E	77 53.7	12817	59760
			1928	26 48.5E	77 54.6	12790	59719
			1929	26 42.9E	77 55.1	12781	59709

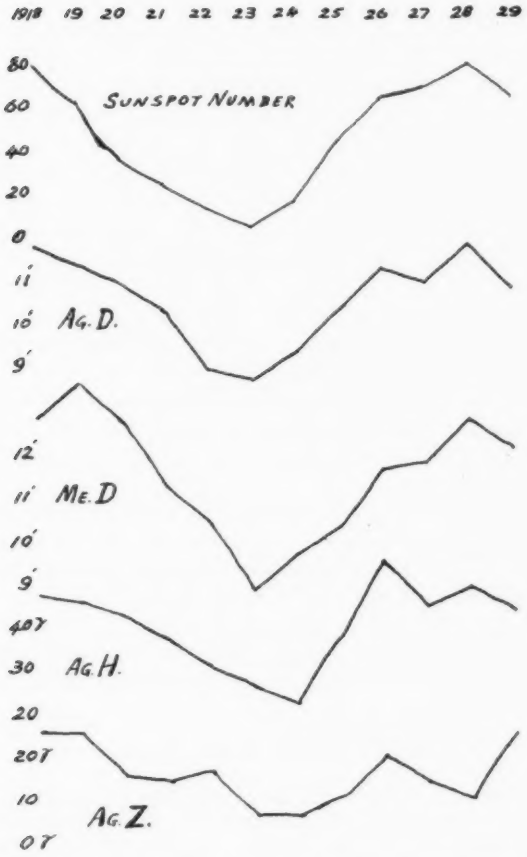
MEAN ANNUAL VALUES OF MAGNETIC ELEMENTS OBSERVED AT AGINCOURT AND MEANOOK FROM 1918 TO 1929 INCLUSIVE—*Continued.*

Agincourt . . .	43 47N	79 16W	1918	6 38.3W	74 44.8	15916	58366
			1919	6 41.0W	74 44.9	15885	58260
			1920	6 45.4W	74 44.6	15865	58166
			1921	6 50.6W	74 44.5	15839	58065
			1922	6 56.2W	74 44.6	15809	57961
			1923	7 0.9W	74 44.3	15784	57849
			1924	7 5.8W	74 44.3	15752	57733
			1925	7 9.7W	74 44.2	15728	57628
			1926	7 13.4W	74 44.6	15692	57527
			1927	7 16.4W	74 44.3	15664	57412
			1928	7 20.3W	74 44.9	15628	57315
			1929	7 24.0W	74 45.4	15586	57196

It has long been known that the diurnal ranges of the magnetic elements vary more or less uniformly with the appearance of sunspots and this is quite plainly seen in the following table and graph. The magnetic diurnal ranges are obtained from the hourly means for each month from the photographic records and the annual mean is the mean of the 12 monthly means. The sunspot numbers are from the published values in the *Astronomische Mitteilungen.*

MEAN DIURNAL RANGES OF MAGNETIC ELEMENTS AND WOLF SUNSPOT NUMBERS

Year	Agincourt			Meanook		Sunspot Number
	D	H	Z	D	H	
	′	γ	γ	′		
1918	11.86	48.6	26.8	12.95	.....	80.6
1919	11.46	47.0	26.8	13.72	.....	63.6
1920	11.01	44.0	16.9	12.85	.....	37.6
1921	10.39	38.6	15.8	11.31	.....	26.1
1922	9.02	32.2	17.9	10.52	.....	14.2
1923	8.78	27.6	7.8	8.94	.....	5.8
1924	9.36	23.3	7.7	9.79	.....	16.7
1925	10.35	38.8	11.9	10.30	.....	44.3
1926	11.31	56.4	21.4	11.72	.....	63.9
1927	10.98	45.4	15.4	11.85	.....	69.0
1928	11.89	50.0	11.8	12.88	76.2	77.8
1929	10.89	44.8	16.6	12.20	75.9	65.0



Graphs showing Sunspot Numbers, Agincourt and Meanook Declination, Agincourt Horizontal Force and Vertical Force.

POPULAR ARTICLES ON ASTRONOMY FOR THE PRESS

By W. E. Harper

Early in 1929 arrangements were made with the Southam Publishing Company for the publication of a series of articles on astronomical topics in their chain of papers across Canada. It was deemed wise not to commence them before the autumn and since then they have, with one or two exceptions, appeared fortnightly in the week-end editions of the various papers concerned.

In the preparation of these articles the writer has had splendid support from many members of the Astronomical Society at the various Centres across Canada who have contributed articles as listed in the accompanying schedule. In nearly every case the articles have been accompanied by illustrations which have greatly added to their value. The articles have been written in a more or less popular vein and appear to have been rather widely read. Many favourable comments have been expressed regarding them.

In this way one of the aims of our Society—the diffusion of astronomical knowledge—has been met and at the same time the treasury of our Society has been benefited through the financial remuneration made by the Southam Publishing Company.

It is hoped to carry on the articles so long as they continue to elicit the interest that has been manifested in them to date.

The writers and their topics to date are as given in the schedule below.

Schedule of Newspaper Articles

1.	1929	October	5	C. A. Chant.....	The Autumn Skies
2.	"	"	19	R. M. Stewart.....	The Ottawa Meeting
3.	"	November	2	J. S. Plaskett.....	The Rotation of the Universe
4.	"	"	16	H. R. Kingston.....	The Distances of the Stars
5.	"	"	30	R. E. DeLury.....	Sun Spots
6.	"	December	14	W. E. Harper.....	How the Velocities of Stars are Measured
7.	"	"	28	A. S. Eve.....	Mirages

8.	1930	January	11	A. R. Hassard	The Winter Skies
9.	"	"	25	Miss A. V. Douglas	Comets
10.	"	February	8	E. A. Hodgson	The Unseen Finger Writes
11.	"	March	8	C. S. Beals	What the Stars are Made of
12.	"	"	22	Sir F. Stupart	Forecasting the Weather
13.	"	April	5	R. K. Young	The Stars in Spring
14.	"	"	19	R. M. Motherwell	The Eclipse of April 28
15.	"	May	3	J. W. Campbell	The Motion of the Sun through Space
16.	"	"	17	C. A. French	Magnetic Work in Canada
17.	"	"	31	C. C. Smith	Rival Clock Makers
18.	"	June	14	R. O. Redman	The Origin of the Solar System
19.	"	"	28	C. A. Chant	The Summer Skies
20.	"	July	12	W. H. Gage	The Heat of the Sun
21.	"	"	26	W. E. Harper	Shooting Stars
22.	"	August	9	P. H. Elliott	Star Clusters
23.	"	"	23	Jas. Duff	The Speed of Light
24.	"	September	6	H. R. Kingston	The Milky Way
25.	"	October	4	P. M. Millman	Keeping Tab on the Heavens
26.	"	"	18	R. M. Petrie	Pulsating Stars

REVIEW OF PUBLICATIONS

Astronomy, by John Charles Duncan, Professor of Astronomy in Wellesley College. 2nd edition, 435 pages, 5½×8½ in. N.Y. and London, Harper & Brothers, 1930. Price $3.75.

The first edition of this book was published in 1926 and its merit was recognized at once. Since then it has been adopted by many colleges as an introductory textbook. The new edition contains many additions and improvements. It has fifty more pages and yet it is less bulky, the paper being thinner but quite satisfactory. Some of the diagrams have been enlarged and there are some new ones as well as a considerable number of new half-tones. The eight light-blue star maps are quite artistic and are better than the former ones. The text, especially the latter chapters, has been extensively revised and made abreast of the latest astronomical researches. The author is to be congratulated on his excellent book.

Star Clusters, by Harlow Shapley. (Harvard Observatory Monographs, No. 2). 276 pages, 5½×8½ in. 3 plates and many diagrams. N.Y.: McGraw-Hill. Price $3.00. 1930.

During the last twenty years the subject of star clusters has grown to great importance in stellar astronomy. Before that time these objects were little more than beautiful curiosities. A brief account of the work done upon them appears in the recent excellent text books, but the bulk of the investigations into their nature and distances has had to be sought for in various periodical publications.

This volume contains a full analysis of all that has been done up to the present in this field, and its value is enhanced through its being prepared by the one who has been chiefly responsible for putting these clusters in the prominent place they now occupy.

The titles of the chapters indicate the thoroughness of the treatment given and are as follows: Introductory Survey; Classification, Number, and Distribution; On the Spectral Composition of Clusters; Variable Stars; Distribution of Stars in Globular Clusters; Forms of Globular Clusters; Structure of Galactic Groups; On the Velocity of Light; Transparency of Space; Period-Luminosity Curve; Distances of Clusters; Dimensions of the Galaxy; Star Clusters in the Magellanic Clouds; Data Bearing on the Origin of the Galaxy; Partial Summary.

In four appendices there are catalogues of globular and galactic clusters and a bibliography of 812 items.

The book is well printed. Hereafter these Monographs will be published by McGraw-Hill for the Observatory.

C. A. CHANT

NEWS AND COMMENTS

The observations of the total solar eclipse made at Niuafou Island in the south Pacific on October 22 were very successful, according to the account given to *Science Service* by Professor S. A. Mitchell, scientific head of the U.S. Naval Eclipse Expedition. It rained during the night and again two hours before totality, but it cleared in time to observe the eclipse through clear skies with very little haze. Excellent photographs were obtained with both the long and short focus cameras. The corona was of the type expected between a maximum and a minimum of sunspots. The spectrum was recorded from λ3200 in the ultra violet to λ7800 in the red. The New Zealand party also secured fine spectra from blue to red, on a scale about one-tenth that of the former. This is Professor Mitchell's eighth eclipse expedition, seven of which have been successful, for a total of sixteen and a half minutes of observation of totality. His impression is that their success has not heretofore been equalled.

Dr. Storrs B. Barrett, associate professor of astrophysics, who has served as secretary and librarian of the Yerkes Observatory for the past thirty years, retired on September first under the regulations of the University of Chicago. He will continue to reside at his home adjacent to the grounds of the observatory. He was succeeded on the same date by Dr. Clifford C. Crump, formerly professor of astronomy at Ohio Wesleyan and director of the Perkins Observatory and more recently professor and chairman of the department of astronomy at the University of Minnesota. (*Science*).

The new observatory on the Rechenberg, near Nüremberg, Germany, has been completed in time for the celebration of the three-hundredth anniversary of the death of Johannes Kepler. In connection with this event there will be an exhibition of objects connected with his life and work. (*Science*).

The Royal Geographical Society, London, celebrated its

hundredth anniversary on October 21 and 22, meeting for the first time in the theatre and library which have been added to the society's house. Representatives were present from some thirty-three geographical societies throughout the world, societies ranging in age from 129 to 4 years. Series of papers were presented on "The Habitable World" and "Incidents in the History of Exploration".

Mr. C. A. French and Mr. R. G. Madill returned to the Dominion Observatory about the end of October having completed their summer's terrestrial magnetic repeat observations at about fifty stations, Mr. French working between Ottawa and Winnipeg, and Mr. Madill between Winnipeg and Banff and north as far as Churchill. They report the usual numerous questionings as to terrestrial magnetism, its variations and the northern lights. One evening after Mr. Madill had explained the nature of the aurora and the production of its colours, there was a splendid display and bright moonlight, and one of his questioners called him to the rear of the train, exclaiming excitedly "Come out quick, the moon is playing hell with the atoms".

Mr. A. H. Miller and Mr. W. G. Hughson of the Dominion Observatory, spent the summer in the field making gravity observations with the torsion balance and pendulum apparatus respectively, at various points in Quebec and Ontario. They have gone out again for a series of observations near Hazeldean, in connection with the investigation of the geological formation there.

"Astronomer is sued for breach of promise. Teach him to quit mooning around." (*The Citizen*).

At the recent meeting of the Optical Society of America, held at the University of Virginia, Dr. Herbert E. Ives reported successful television transmission and reception of a colour motion picture. Is it too much to hope that the total solar eclipse of August 31, 1932, which passes so favourably down through Hudson Bay, Quebec and Maine, may be broadcast so that people throughout America at least may see it in all its colour glory? It is possible; as also a daily broadcast of the solar image in various wave-lengths so that each may see what is in store for the earth from the activities of the sun. Will Dr. Hale kindly oblige by initiating such a service on red Hydrogen alpha? REDeL.

Notes from the Dominion Astrophysical Observatory, Victoria, B.C.

The observing weather has been slightly above the average for the month. The twelve-year average for October shows 16 nights observing with a total of 125.0 hours. In the past month there have been 18 nights with a total of 143.3 hours.

The number of visitors to the observatory falls off at the winter season of the year. August was probably a record with approximately 12,860, September dropped to 2136, while October showed 711. These munbers are only approximate but err, if at all, in being too conservative.

Two graduate students, Messrs. MacDonald and McKellar from the University of British Columbia, spent a portion of the summer vacation at the observatory. Mr. H. H. Plaskett and Dr. P. ten Bruggencate each spent about three months here, the former obtaining nebular spectra, the latter spectra of cepheids.

Mr. P. M. Millman, a former summer assistant, paid a one day visit to the observatory at the end of August, when he gave a short talk on his work at Harvard. He expects to publish soon one of the binaries he investigated while here.

The writer attended the Chicago meeting of the A.A.S. and renewed acquaintances with some of the Toronto and Ottawa people, as well as many of the American astronomers.

From time to time new equipment is secured here which may not seem important enough for a special article, yet which should be noted. A few months ago a 14-inch brass globe was turned out by a local machinist, S. S. Girling, for use in the measurement of angular distances. It was made in two hemispherical sections, screwed together and the whole sphere nickelled with a matt surface. The work has been executed so beautifully that no trace appears of the joining. On it are marked the equatorial coordinates in both directions, the lines being ruled 10° apart. The ecliptic and galactic circles are also shown. By means of an auxiliary quadrant it is possible to read rapidly angular distances from any reference line to a minute of arc. Conversion from equatorial to galactic coordinates can be rapidly checked in this manner. The globe is mounted on a pedestal which rotates freely. W. E. H.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Eros—the Date of its Opposition

In the note on Eros in the last issue (p. 434) the date when Eros will be in opposition was given as January 29, 1931. This is a mistake. It should have been February 17, as stated under the diagram of its path.

The Velocity of Alpha Centauri

In a letter to the Editor Professor Frank Schlesinger draws attention to an error in the article by Professor E. G. Hogg, printed in our last number (p. 406). It is stated that Alpha Centauri is receding at the rate of fourteen miles a second, while actually it is approaching at that rate, and consequently its nearest approach to the earth will take place some twenty-five centuries hence, instead of having occurred that length of time ago. He states that this error arose from a misprint in the Lick Bulletin which gave the first velocity of the star.

Professor Schlesinger also remarks that Mr. Hogg uses the word "billion" in its two senses and is led to the very erroneous statement that Proxima and Alpha are twelve times as far apart as the earth and the sun while they are about 12,000 times as far apart.

It is also stated that the Committee on Notations of the International Astronomical Union will likely recommend the discontinuance of the word "billion" and the substitution therefor of "thousand million" or "million million" as the case may require.

A Bright Meteor seen in Hamilton

Mr. T. H. Wingham sends some reports of observations of a bright meteor seen at about 7.30 on the evening of November 3. Mr. P. Ryan thought it was travelling south, practically parallel to the street he was on which runs slightly west of south to slightly

east of north. Colour reddish; train at least fifteen times the diameter of the head which was brighter than his recollection of Venus; visible for three to five seconds; so low that he involuntarily ducked his head; was sure it must have buried itself on top of the Mountain. Miss Wallace saw it while on Ottawa St.; seemed to be over the centre of the city (two miles away); visible about 4½ seconds; silver-grey in colour; travelling south; brighter than Capella. Another young lady gave the colour as white, slightly bluish; brighter than any star; had a trail "about two blocks long"; was travelling very fast. Both stated that the meteor disappeared before reaching the horizon.

Ritchey's Great Project

In this Journal during 1928 and 1929 there appeared six articles by Professor G. W. Ritchey on the modern photographic telescope. He described a new type of reflector invented by himself and Professor Henri Chrétien, of the Observatory of Nice, in which, he claimed, the field of sharp images is much larger than in the ordinary reflector. Professor Ritchey also devised a cellular construction for the mirror to replace a solid disc.

In order to test his ideas he made a telescope of aperture 20 inches for the Duc de Gramont. It is declared to have been a success and is now being removed to Miami, Florida, where it will be used to make astronomical photographs during the winter. If the atmospheric conditions prove satisfactory, it is reported that a group of Detroit men will provide the funds for the erection of a telescope with an aperture of 20 to 25 feet, which is far larger than even the 200-inch projected by the Mt. Wilson Observatory and California Institute of Technology.

Professor Ritchey has a distinguished record as the builder of the 60-inch telescope and of the optical parts of the 100-inch, of the Mt. Wilson Observatory, and the scientific world will wish him success in this new adventure.

Astronomical Papers at the National Academy of Sciences

Recently some interesting papers were presented at a meeting of the Academy in Washington, and an outline of four of them follows, substantially as in the official report.

Rotation of Uranus and Neptune, Determined Spectroscopically

The investigation was made jointly by Drs. J. H. Moore and D. H. Menzel at the Lick Observatory. In 1911 Lowell and Slipher found from their spectrographic observations of Uranus that the planet is rotating in the same direction as that of the revolution of its satellites and with a period of 10¾ hours. Leon Campbell, Slavenas and others have reported a variation in the planet's light in very closely this period, while Stebbins, from observations made with the photoelectric photometer, concluded that the light of Uranus is constant. Recent observations obtained at the Lick Observatory with spectrographs of three-prism and one-prism dispersion confirm the direction of the planet's rotation as found by the Lowell observers. The period of rotation derived from fifteen one-prism spectrograms in 1928, 1929 and 1930 is of the order of that previously found. The three-prism spectrograms to which exposures of 6 hours were given are under exposed and difficult to measure. The period derived from two of these obtained in 1927 is 11.5 hours. A consideration of the probable sources of the discrepancy in observations of planetary rotation obtained with different spectrographs shows that for objects like Uranus and Neptune, with small apparent disks, the rotation period determined spectrographically is at best only approximate. Seven well-exposed spectrograms of Neptune were obtained with the one-prism spectrograph in 1928. The slit was placed parallel to the planet's equator, the position of which was derived by Eichelberger and Newton on the assumption that the well-known motion of the plane of the satellite's orbit is caused by the attraction of an equatorial protuberance on the planet. All these spectrograms show a very noticeable inclination of the spectrum lines, in the sense that the portion of the line, originating at the east limb of the planet is displaced toward the violet, indicating that the rotation of Neptune, like the other planets, with the exception of Uranus, is direct. The measured inclination of the lines yields an approximate period of rotation for Neptune of 15.8 ± 1.0 hours.

Evidence of Interstellar Light Absorption

In an investigation of open star clusters Dr. Robert J. Trumpler of the Lick Observatory obtained definite evidence that within our Milky Way system light suffers a loss of intensity while passing through interstellar space. The evidence is based on the fact that distances of open star clusters derived from their angular diameters do not agree with those derived from magnitudes and spectral types of the stars. We also find a change of colour with distance for stars of the same spectral type, which indicates that the absorption is selective, *i.e.*, that it depends on the wave-length of the light. In order to gain information on the physical process causing this absorption and on the nature of the absorbing medium, it is of prime importance to find the law according to which the absorption depends on the wave-length. For this purpose the spectra of the brighter stars in the clusters N.G.C. 6910 and N.G.C. 6913 (distance about 2,000 parsecs) were observed with the slitless quartz spectrograph of the Crossley Reflector and compared with the spectra of relatively near stars of the same spectral type. Taken on Panchromatic plates these spectra cover the region from 6300A to 3200A

and show at once the great difference in the intensity distribution of the continuous spectrum between near and distant stars. This difference, which must be an effect of interstellar light absorption, was measured with a Moll self-registering microphotometer. The results show that the absorption increases rapidly with decreasing wave-length; but the absorption does not seem to be inversely proportional to the fourth power of the wave-length, which law should hold if the effect were due to Rayleigh scattering by extremely small particles.

Velocity-Distance Relation among Extra-galactic Nebulae

Dr. Edwin Hubble in previous investigations at Mt. Wilson showed that the velocity (of recession) of nebulae outside of the Milky Way was directly proportional to their distance away, being about 500 km. per sec. for each million parsecs and holding out to a distance of about 2,000,000 parsecs. Thirty-four new velocities, sixteen of which are of objects in four very distant clusters, confirm this relation and extend its range out to about 24,000,000 parsecs. Distances of clusters and groups of nebulae are determined from the mean magnitudes, the zero-point being derived from nebulae in which stars can be seen.

Lunar and Planetary Temperatures

At Mt. Wilson Drs. Edison Pettit and Seth B. Nicholson have made further measures of the radiation from the moon and the planets with a thermocouple placed in the principal focus of the 100-inch reflector. The radiation from the moon was measured during a total eclipse, and from the rate of cooling some idea of its heat conductivity was obtained. The resulting temperature of the sub-solar point on the moon was 374° K (101° C or 214° F), and of a point on the night-side, less than 120° K. The temperature of a point where the altitude of the sun was about 20° fell from 342° K before the lunar eclipse to 156° K after 2h 40m immersion in the umbra of the earth's shadow. The maximum temperature of Mercury is about 655° K. The distribution of radiation over its surface is much like that on the moon. Venus is covered with clouds and the radiation measured is from the high cloud surfaces and, except by inference, tells very little about the actual surface temperatures. The measured night temperature on Venus is about 241° K which is much higher than that on Mercury or the moon. The temperature on Mars varies greatly with the season and the time of day. With the sun in the zenith at perihelion it measures 296° K; at aphelion this temperature would be reduced 27°. The outer planets are very cold, as might be expected from their great distances from the sun, unless they give off heat from their interiors. The thermocouple measures show that the temperature of Jupiter is about 135° K and, therefore, that very little of the radiated heat comes from its interior.

Perkins Observatory open to Ohio State Students

In accordance with an agreement made by the Boards of Trustees of Ohio Wesleyan University and Ohio State University, students registered in the latter institution may carry on research work in Astronomy and Astrophysics at the Perkins Observatory of Ohio Wesleyan University under the supervision of its Director.

Graduate work may be arranged on the terms of the agreement which will lead to the degree of Doctor of Philosophy in Astronomy and Astrophysics, the degree to be granted by Ohio State University, and the work to be published in the contributions of the Perkins Observatory.

An Enormous Cosmic Velocity

In the March issue (p. 148) were given some of the extraordinary velocities of faint nebulae obtained at the Mount Wilson Observatory. They ranged from 650 to 7,800 km./sec. recession. It will be remembered that Slipher obtained similar results some years ago. The latest velocity given is much greater than all those previously secured. At the recent meeting of the Pacific Division of the A.A.A.S., of which an interesting report is printed in the present issue, it was announced that Humason, after a 50-hour exposure with a specially constructed spectrograph attached to the 100-inch telescope, had obtained a spectrogram of a faint nebula in Ursa Major from which a velocity of 11,500 km./sec. had been deduced.

It is hard to believe that these velocities are real—that the effect is a simple Doppler displacement. It is not likely that all these distant nebulae, in their various directions, are receding from us with such tremendous velocities. It is to be noted, also, that the most distant ones have the greatest velocities. Hubble has deduced the distance of this cosmic runaway as 75 million light-years.

These results should surely be received with caution. It has been suggested that it is more probable that the light-waves as they travel through these immense distances, increase their wave-length. It is surmised, also, that this effect is connected with Einstein's so-called curvature of space. It would appear that some fundamental developments are being made.

SOME NEW BOOKS ADDED TO THE LIBRARY RECENTLY

W. T. OLCOTT: A Field Book of the Skies.
J. K. ROBERTSON: Introduction to Physical Optics.
O. THOMAS: Heaven and Earth, a Modern Astronomy.
R. H. BAKER: Astronomy.
HARLOW SHAPLEY: Star Clusters.
R. T. CRAWFORD: Determination of Orbits of Comets and Asteroids.

C.A.C.

MEETINGS OF THE SOCIETY

AT TORONTO

October 7—A regular meeting was held in the Physics Building of the University of Toronto at 8 p.m., Mr. J. R. Collins in the chair.

The Chairman brought to the attention of the meeting a small pamphlet published by the Astronomical Society of the Pacific, containing astronomical information of popular appeal. It was suggested that this Society follow the example with the view of interesting new members. It was therefore resolved to put the matter before the General Council.

Mr. A. F. Hunter, Mr. Fred. Troyer and others described some of their observations during the past summer.

The Chairman mentioned that arrangements were being made that would enable the public to view the heavens with telescopic aid, either at certain of the members' residences, or posted at advantageous points in the city. It was hoped to complete these arrangements in time to view the moon at, or about, the coming first quarter phase.

Mr. A. R. Hassard spoke at length upon the constellation Lyra, mentioning interesting points about the ancient lore connected with it, as well as the colours of the stars, their distance and grouping. A description was given of the Ring Nebula, and of the passage through Lyra of the last appearance of Pons-Winnecke Comet.

The chairman then gave a summary of the discovery and later knowledge of the new planet Pluto, also an account of the wonderful mathematical discovery of Neptune. He also described the appearance of several of the new stars, and their subsequent development.

Mr. A. R. Hassard voiced the deep regret of the members at the passing of our esteemed Member, the late Major A. D. Armour, K.C., and moved that a letter of condolence be sent to his widow. The motion was seconded by Mr. A. F. Hunter, and carried.

October 21—A regular meeting was held in the Physics Building of the University of Toronto on October 21 at 8 p.m., Mr. J. R. Collins in the chair.

The following were elected to membership:

Arthur Conrad, 234 Roslyn Avenue, N.W., Canton, Ohio.
B. L. Souther, Ph.D., Mellon Institute, Pittsburgh, Pa.
J. P. Molinos, First National Bank of Boston, Havana, Cuba.
Mercial Oakbough, 1781 Haight St., San Francisco, Cal.
L. I. Waite, 46 Bennett Avenue, Binghampton, N.Y.

Jas. P. Sands, Nassau, N.P. Bahamas.
Geo. C. Claridge, St. Norbert's College, West De Pere, Wisconsin.
L. S. Shively, 407 Riverside Avenue, Muncie, Indiana.
Mrs. Gladys Wood, 23 Colin Avenue, Toronto.
Stephen Stoot, Laframboise St., Ste. Hyacinthe, Quebec.
John M. Grant, P.O. Box 661, Orillia, Ont.
Miss Mary Graham Tunnah, Box 191, Rosthern, Sask.
F. Morley Morris, 2067 Rae St., Regina, Sask.
Vivian D. Stead, 127 Stibbard Avenue, Toronto.
J. R. Hamilton, 15 Lisgar St., St. Catharines, Ont.
H. W. McAll, 134 Farnham Avenue, Toronto.
Dr. J. R. Jones, Sudbury, Ont.

The chairman referred to the observation nights shortly to be arranged for the benefit of the public.

The committee appointed to draft a letter of condolence to the widow of our late member, John A. Paterson, reported that this had been done, and the letter was read to the meeting, as follows:

May 19, 1930

Mrs. John A. Paterson,
91 Northcliffe Boulevard, Toronto.

Dear Mrs. Paterson:

At the regular meeting of the Royal Astronomical Society of Canada held on the 15th instant, the undersigned were asked to express to you the deep regret with which the members of the Society had learned of the death of your husband.

Mr. Paterson was elected a member of the Society on December 2nd, 1890, the first year of its corporate existence, and a year later he was chosen Vice-President. During 1896 and 1897 he was President, and for all the years up to his last illness he took an active interest in the work of the Society. His many contributions to its programme were highly appreciated, and he was always ready to assist in any scheme to improve its status and widen its influence.

All of us became acquainted with Mr. Paterson in the early days of the Society and we all admired his great ability and his fine sense of duty to the community. We would add an expression of our personal regard for Mr. Paterson and his long and useful life.

Very sincerely yours,
A. F. Miller,
J. R. Collins,
C. A. Chant.

Mr. R. S. Duncan, the curator, stated that a telescope belonging to the Society had been returned and was available for any member who could use it. Dr. Chant remarked that he was frequently asked for small telescopes to buy.

A discussion took place as to the reason for the concave aspect of the earth as seen from an airplane, mirage and looming effects, and the enlarged appearance of the moon when near the horizon.

In the absence of Mr. S. C. Brown, Mr. J. R. Collins spoke on the constellation Cygnus, giving the positions and distances of the various stars composing that group.

The chairman then stated that Mr. J. A. Marsh, whose name was on the programme for this evening, was not able to be present, and Dr. Chant had kindly consented to fill in. Dr. Chant began by stating that Flamsteed and the astronomers succeeding him for over a century gave most of their attention to making star catalogues and maps and getting accurate positions of the stars. The new astronomy, or astrophysics, had its inception about 1859, though Newton might be considered as its originator; he broke up a ray of light into its spectrum in 1668. Later, Fraunhofer, 1814, who was apprenticed to optical work, experimented with sunlight passed through a slit and prism and received in a telescope; he saw the solar spectrum and the dark lines across it, and he mapped the lines. These dark lines have been called by his name ever since. Comte, the French philosopher, had said that man could never find out the physical constituents of the heavenly bodies, but the manner of obtaining such knowledge was soon after discovered by Kirchhoff. He demonstrated that there must be iron and sodium in the sun. In Heidelberg the speaker had been interested in noticing an engraved plate on a house in the Main street, which stated that in that place Kirchhoff had invented spectrum analysis, and had disclosed the physical nature of the stars. At the present time 58 of the elements known have been recognized in the chemistry of the universe. William Huggins, a young man, was drawn to astronomy, and established an observatory in 1856, wherein he observed the planets and did other ordinary work. Kirchhoff's work directed him to spectrum analysis and he applied it to the stars by attaching a spectroscope to his telescope. This led to astrophysics as we have it now. In 1885 Balmer found a mathematical expression for the wave-lengths of lines in the hydrogen spectrum as observed in the laboratory and at the present time perhaps two-thirds of the work in astronomy is devoted to astrophysics.

ERRATUM

On page 344 in the Berkeley elements of Pluto the value of q should be 29.54942.

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THE JOURNAL

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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PUBLISHED MONTHLY
(*Ten numbers per year*)

Volume XXIV, 1930

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

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